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FUNDAMENTALS GOVERNING SEPTIC TANK DESIGN AND INSTALLATION

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Environmental Health Center
Cincinnati, Ohio

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CINCINNATI, OHIO

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Introduction

The disposal of human excreta in early days was comparatively simple, and is still so in some of the rural sections, the chief development being the improvement of the privy. With increasing population in communities came the serious problems of public sanitation, which were not relieved materially until public water supplies and water-borne sewerage became established. Such facilities are not new - in the ruins of the ancient city of Knossos on the island of Crete, where the Mycenaean civilization flourished about 1600 B. C., may be seen the remains of extensive water supply and drainage conduits and even water-flushed toilet stools. It is only recently, however, during our modern industrial civilization that such conveniences have been available to the majority of the people. Today, the conveniences of modern plumbing are demanded, not only in built-up communities where public water and sewerage systems are provided, but in rural and semi-rural areas as well. The availability of such services, and of electricity and modern transportation, together with the desire of many people for uncrowded living, is profoundly affecting the pattern of development of the modern American city, with consequent residential development in outlying fringe areas where community sewerage systems often cannot be provided economically. Under these present circumstances, the individual home sewage disposal system is an important segment of American sewerage practice.

* For presentation at the Inservice Training Course for Plumbing Problems at the University of Michigan, School of Public Health, at 10:30 A. M. to 11:15 A. M., September 16, 1950.

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As an indication of the size of this field, consider that, on the basis of 1945 figures, municipal sewage treatment in this country served some 47,000,000 persons. Of these, about 22,000,000 are served by refined treatment processes, that is, processes furnishing treatment beyond plain sedimentation, and comparable with the individual septic tank soil absorption system. Compared with this is the 17,000,000 persons estimated connected to individual household septic tank-soil absorption systems. With respect to numbers of plants, there are an estimated 4,400,000 individual household plants as compared with 5,700 municipal sewage treatment plants in this country. The tremendous number of plants in the individual system field, as compared with the number of municipal plants, is reflected in the volume of inquiries and complaints reaching public desks. Complaints on individual systems have amounted to as many as 300 per month in one county.

Objective of Residential System

The objective of the individual household sewage disposal system is the safe and convenient disposal of human and other domestic wastes in a manner not hazardous to the health of the family itself, or to the community, and to do this without nuisance or esthetic damage. Specifically, the disposal should be accomplished without pollution of private or public drinking water supplies, bathing waters, shellfish grounds, or waters used for recreational purposes, and in such a way that the facilities will not be accessible to insects, rodents or other possible carriers of disease, and without odor nuisance or unsightly appearance.

Types of Systems, Functions of Units

The individual household disposal system starts, of course, with the house sewer. There may be one or more sewers leaving the house, depending

on the design. In some cases kitchen wastes are led out separately to a grease trap, following which one of several procedures may be followed: They may be discharged through the septic tank, or they may be by-passed around the septic tank to enter the soil absorption system, or they may be discharged to a separate absorption system. Other schemes of separation of wastes also are used sometimes, such as, discharging toilet wastes only, or bathroom wastes only, through the septic tank, with the discharge of other wastes to a separate absorption line, etc. The common practice, however, is to discharge all household wastes through one outlet.

I will mention the grease trap only because it has received considerable attention. Most modern design recommendations in this country do not include a grease trap on a residential system. They are, however, commonly recommended for systems on restaurants, road houses, institutions, etc. where sizeable amounts of kitchen greases are discharged and where there is some chance that they may receive suitable maintenance.

The cesspool, although it is still used in some localities, has become pretty well recognized as a source of operating difficulty in anything but the most porous type soils. It is not recommended nor approved in many states and localities. Michigan, for instance, neither recommends nor approves cesspools. The usual cesspool is a well, the lower section of which is lined with open-joint stone or brick, with an upper section of closed joint construction drawn in to support a manhole or slab top. The raw household sewage enters near the top and the liquid is expected to pass out through the open joints to the soil.

Most household sewage disposal systems use a septic tank which serves as a settling, sludge digestion and sludge storage tank, and prepares the sewage for absorption in the soil or treatment on subsurface filters. The combining of these three functions in one tank is, perhaps, not the best arrangement technically, but it has many merits from the practical standpoint

of simplicity, ease of maintenance, and low cost, both in the installation and in operation. Structurally, the septic tank consists of a watertight chamber equipped with sewage inlet and outlet appurtenances arranged to minimize short-circuiting of the sewage through the tank, and to hold back the scum and settled sludge. Along with this is provision for passage to the house stack of gases from the tank, which is a normal consequence of sewage solids digestion, and gases from the soil absorption system. Provision also is made for access to the tank for inspection and removal of sludge and scum.

The system for absorption of the tank effluent in soil may take various forms. Most commonly, when tests show the shallow soil in a particular site to provide promise of adequate absorption, a system of open joint or perforated conduits laid in gravel in the bottom of shallow trenches serves to distribute the septic tank effluent to the soil. The typical trench is 18 inches wide, 18 to 24 inches deep, with 4 inches of gravel beneath the tile, 2 inches above, tar paper shields over each joint, and a layer of hay, straw or building paper separating the gravel and backfill. Where the shallow soils are impervious, tests may show the opportunity for absorption in underlying porous layers, and in such a case, a seepage pit may serve as the means of distribution to the soil. A seepage pit is constructed similarly to a cesspool, the difference being that the seepage pit receives septic tank effluent while the cesspool receives raw sewage. This does not mean that the seepage pit may not be a health hazard. The local environmental factors must be considered in designing or installing any type of absorption system.

Where neither upper nor lower soil strata offer absorption possibilities, the alternatives are the subsurface sand filter, and the sand filter trench, the former a bed of sand, above and below which are located open joint or perforated pipes, laid in gravel, for distribution and collection of the sewage

and the latter, an elongated bed of similar construction. Both receive sewage after its passage through the septic tank, for treatment by filtration through the sand, and disposal to a surface water-course. This increases the public health hazard. In such cases, the public health and nuisance effects of such discharges must be considered and special authorization from the health department is required.

It is obvious that if a single absorption line or sewage pit is used, the tank effluent may be passed directly to it. Where multiple absorption lines are used, a means of distributing the tank effluent to the several lines on approximately a uniform basis must be provided. Commonly, this is done by a distribution box. This is a small box into which the tank effluent passes and is distributed uniformly to the several lines by means of a stilling baffle and individual outlets carefully set at the proper elevation. In some types of system it is possible to rotate or alternate the use of absorption lines, providing a resting period for some, while others operate. This is controlled at the distribution box by manipulation of slide gates or by simply plugging off lines to be rested. The distribution box may also serve as an inspection point for the septic tank effluent. In some areas, however, the distribution box is eliminated, the attempt being made to obtain proper distribution by the substitution of a pipe header from which the individual lines branch from tees or wyes. This method of distribution would be difficult to obtain under laboratory conditions, let alone field installation circumstances. It is not too practical.

The open joint or perforated conduit and trench type of absorption system is commonly represented by several patterns of installation. A common pattern is a series of parallel lines each connected directly with the distribution box. A closed rectangle, with the distribution box located in one side,

is another pattern. A third type is the divided rectangle, split either longitudinally by what amounts to a third lateral connected directly to the distribution box, or transversely by a line connecting the two sides. The topography of the site, and the size and shape of the lot, determine the pattern. In broken terrain, laterals are usually oriented along contours to avoid excessively steep grades. Sometimes a single-line, downhill-zigzag pattern is used, with the open joint tile lines laid along contours and short connectors at alternate ends running downhill.

Problems

First, from the design standpoint, one of the chief obstacles to reasonable septic tank performance has been the tendency to skimp on capacity in order to reduce first cost, or to obtain a competitive advantage in low first cost. This is false economy. The difference in cost for different sized tanks is very small. The sludge and scum storage functions of the septic tank depend directly upon tank capacity, and the installer, or the owner, who has squeezed a few dollars out of the initial cost saddles the occupant with the necessity of paying for frequent tank clearnings at a cost which normally far exceeds the saving due to decreased tank capacity. Furthermore, the probability of major spill-over of sludge from a full tank and consequent clogging of the soil absorption system is increased when frequent cleanings are required. The difficulty does not end here, however. Operating runs between tank cleanings involve breaking-in and tapering off periods, during which tank performance is not at high efficiency, and more solids are discharged to the absorption system. Consequently, the larger, long run tank will impose less of a burden on the soil system through discharge of solids than will the small, short run tank. This is important, because although the functions of a sludge loaded septic tank may be renewed through cleaning, a

clogged soil absorption system ordinarily can only be renewed by replacement. In short, the small tank is not a wise investment at any price. I hope at this time none of you has the impression that a septic tank can be forgotten after installation; that it will never have to be cleaned.

Other septic tank difficulties stem from lack of proper inlet and outlet fixtures, intercompartment flow devices, and, surprising as it may seem, sometimes lack of suitable means of access for inspection and cleaning.

As for soil absorption system design problems, it appears that testing of water absorption capacity of the soil by percolation test, and design of the system size on that basis, is not applied as widely as it should be. Except for very porous sandy soils or for very tight clays, the decision on whether a soil will be suitable for an absorption system, and how much area and length of tile are needed, on the basis of anything less than percolation tests, may lead to failure. Except for the extremes above mentioned, even the trained soil scientist must use percolation tests to determine water absorption capacity with any accuracy. Soil structure, not texture, is the important factor. The usefulness of gravel packing about the conduit and careful laying of lines to grade should be kept in mind.

The effectiveness of a good design may be lost, however, through careless installation or maintenance. A few difficulties resulting from careless installation might be mentioned here, such as the exposure of open trenches to freezing weather during construction, followed by a system freeze-up during initial operation; tile lines laid at uneven grade resulting in poor distribution; lines laid at steep grades resulting in surface seepage at the lower end; inlet baffle broken by ramming sewer pipe into tank; inlet clogging due to pushing sewer against baffle; and inlet clogging because of obstruction building up on ragged end of sewer inlet. There are instances of tanks installed backwards, an easy mistake to make for some types of prefabricated

tanks. Operating difficulties sometimes stem from structural causes. The coatings on steel tanks are sometimes damaged by rolling them over stones. Thin-walled prefabricated concrete tanks are sometimes cracked by careless handling.

Another type of difficulty results from a poor layout, which may be due to faults of both design and installation. One bad layout coming to mind is that in which the septic tank is located in a pocket or low ground, with absorption lines sloping downward into higher ground. Such systems have been known to drain the high ground in wet weather, resulting in tank flooding and a surface pool at the tank. Some instances of tank flooding due to discharge of roof drainage in the vicinity of an absorption field are also known. The consequence is a roiled tank, scum overtopping the outlet fixture and a sluggish absorption field thereafter, even in dry weather.

One of the major installation shortcomings, which puts the owner at a disadvantage, is the failure to provide a record layout of the system, and instructions for the small amount of maintenance and attention he should give his system. It has been our experience during field inspections in several areas over the country that the householder is usually uninformed as to the location of the facilities and what he should do for maintenance. There is no lack of interest, however, and it is our opinion that many present operating difficulties will disappear once the householder is given the information he should have. The amount of attention required is very small actually, but it is too often left until sewage backs up in plumbing fixtures or the cellar.

Factual Studies, Recommended Procedures

For over three years, studies of household sewage disposal systems have been under way at Cincinnati, conducted by the Public Health Service in cooper-

ation with the Housing and Home Finance Agency. The intent and purposes of the studies may be simply stated as an attempt to find out what actually happens in the residual sewage disposal system and its parts under various loading and environmental circumstances. With this basic information it should be possible to develop recommendations for design standards that would be fundamentally sound, because they are based on factual information, not opinion. Design standards, so evolved, will result, of course, in overall economies of construction and maintenance. The results of our studies to date give confirmation of this.

Starting with the household waste, you will appreciate that both in quantity and composition the wastes to be treated in a particular installation are the result of living habits in a particular home, and are not the composite wastes of many homes as represented by a municipal sewage. Therefore, while averages are of interest, we must ultimately deal with an installation which will suit most, if not all, cases. So far as volume of wastes is concerned, we have obtained metered water supply data from septic tank system residences, which serve as a guide to the daily volume of waste until data on gagings of wastes become available. Summer water consumption averaged 49 gallons per capita per day and winter consumption 39 gallons per capita per day. We would expect the average waste volumes to be within these limits, probably close to the winter figure. For individual residences, however, the waste flow may be as low as 8 gallons per capita per day for some homes and range up to some 150 gallons per capita per day for others, in winter. In summer the spread is greater, ranging from 8 to 226 gallons per capita per day in the cases we examined. Household habits also affect the character of the waste. As you know, some homes have garbage grinders, automatic washing machines or water softeners, or all of these; other homes, none; also, home practices in the use of soaps or detergents affect the character of the waste to be treated.

For those of you in areas subject to severe winters, I might point out that we learned that pipes under driveways or other hard surfaces usually cleared of snow are subject to freezing and should receive special protection, This concerns the house sewer particularly.

Grease traps are not usually recommended for individual residential sewage disposal systems. Considering that there is advantage to combining the wastes for seeding and digestion, that the septic tank on account of its design and larger size is actually a better grease retainer than the usual small grease trap, and that the septic tank has a better chance of being serviced, the point is well taken. With entry of detergents into household habits, it is likely that less grease will be removed by plain hydraulic separation, such as in a grease trap or septic tank.

Coming to the septic tank studies, it is of interest concerning the tank shape factor that five single compartment septic tanks, all of approximately 500 gallons capacity but of different shapes, including vertical and horizontal cylinders, rectangular and oval shapes, were operated for a year at the laboratory, all under the same circumstances of loading, accelerated sludge accumulation and other details of operation. The suspended solids removal efficiencies of all five tanks, for the year, were between 59 and 65 per cent. In other words, for the same capacity, variation in shape appeared to affect efficiency very little. All five tanks were operated at liquid depths of roughly four feet. The variation in depth was too small to be indicative of behavior under any radical departure from four feet, although it appeared from this that a small variation, say of half a foot, would make little difference in efficiency as compared with the four feet depth. Study of the depth factor is now under way. Keeping the 59 to 65 per cent suspended solids removal in mind, it is also of interest that a 2,000 gallon single compartment

tank operated under the same sewage loadings, but with larger sludge additions, gave an 82 per cent removal, and that two multi-chamber tanks of 550 and 670 gallons capacity respectively, under the same loading and sludge accumulation conditions as the five single-chamber tanks, gave removals of 78 and 84 percent respectively. These performed, then, at roughly 20 points above the single tanks in the 500 gallon size. Smaller tanks, both single and multi-chamber, operated at respectable efficiencies for a very short time, reaching sludge storage capacity quickly, and of course this would mean frequent cleanings. Our conclusions are, consequently, that variation in shape of single compartment tanks within reasonable limits does not affect efficiency greatly if capacity is adequate; that some sort of compartmentation appears desirable; and that while no unqualified conclusion on capacity can be drawn from the study thus far, we believe that at least 500 gallons should be provided to enable reasonably long periods of trouble-free service, and to prevent frequent and progressive damage to the absorption system due to sludge discharge.

A total of 300 single household type septic tanks were examined in nine areas over the country. Such examinations were of primary interest for the establishment of rates of scum and sludge accumulations, but there were other factors of interest, some of which have been reported upon. Concerning person loads, it appears that, on the average, the number of persons per dwelling is about 3.8; persons per bedroom, 1.5; bedrooms per dwelling, 2.5; also, that the person per bedroom load increases as the size of the dwelling decreases, that is, the higher person per bedroom loads are found in the smaller homes.

Concerning structural tank materials, it appears that corrosion is most severe, inside the tank, at and above the water line. In general, precast concrete, tile and brick stood up well for twenty years or more; poured-in-place concrete, for at least ten years (no data for older tanks); steel tanks, a seven-year useful life on the average, running as high as twelve years in individual cases in the group of tanks examined. Wood baffles were found

found in tanks up to seven years old (no data for older installations). I might mention here that the larger steel tank manufacturers have invited the cooperation of the Bureau of Standards in setting up a proposal for a voluntary commercial standard for household metal septic tanks. A draft of the proposed standard includes design specifications for both cylindrical and rectangular tanks and coating requirements in some detail. The tentative standard is being submitted to the industries as a whole for indication of acceptance.

Several exploratory trials of tank inlet, outlet and inter-compartment flow appurtenances have been made in our Cincinnati tests, using uranin dye as a tracer. Ultimately, suspended solids performance trials will be carried through on promising arrangements. Comparisons of a tee inlet, a baffled sewer inlet, and a plain sewer inlet, indicated that there was essentially no difference in the effective detention time among the three inlets. There was, however, an indication of a slightly better flow pattern for the tee inlet, followed by the baffled inlet and the plain sewer inlet in that order. Operating two three-compartment rectangular tanks, one equipped with inverted U's between compartments, and the other, first with a 4-inch horizontal tank-width slot, and later with a 4-inch diameter hole, both submerged 12 inches to the top of the opening, it was found that the slot at this position gave the same effective detention time as a tee fitted single compartment tank of equal capacity and only half the effective detention time of the inverted U-equipped compartmented tank. Upon constricting the slot opening to that of a 4-inch diameter hole at the same depth the detention period lengthened, but did not come up to that of the inverted U-equipped tank. These are, of course, at one position, and other locations are to be investigated. One experiment on outlets has been performed in which there was no essential difference in suspended solids removal from two identical tanks, one operated with a tee outlet and the other with a baffled tank-width weir. Other outlet experiments are under way, in connection

with the depth studies, in which the behavior of tanks with respect to depth and also with respect to the distance between top of the accumulating sludge and the bottom of the outlet is being observed. These are not far enough along to report at this time.

Concerning scum and sludge accumulations, it appears that scum plus sludge tends to accumulate volumetrically in the septic tank at a higher rate per person per year in the earlier years of tank service than after some six years of operation, after which it appears to increase at a more or less constant rate. Here again attention should be given to variation from the average.

For tanks examined in the field, the greater rates of annual sludge and scum accumulations occurred with tanks of large capacity, the average rate of accumulation being found with tanks having capacities of 125 to 175 gallons per person served. Such accumulations might be used as a rough measure of the change in efficiency of suspended solids removal caused by variation in tank capacity. On the average, scum was found to accumulate at the rate of 0.43 cubic feet per person per year during the first three years of operation, and at the same rate for the first six years of operation. Sludge accumulated somewhat faster on the average, 1.28 cubic feet per person per year during the first three years and 0.95 cubic feet per person per year, for the first six years. However, as might be expected, there was found to be wide variation in such figures. In order to cover the variations that might be expected to occur, it appears that capacity should be provided for three times the average rate of scum accumulation for the first three years, and about twice the average for six years of operation; for sludge, similar allowance of about double the average rate of accumulation apparently should be made for the first three years of operation and one and one-half times the average rate for six years. Further concerning scum, it was found that 27 percent of the scum thickness was above the water line.

The matter of intervals between cleaning, or the point at which a tank should be cleaned is important. There is indication in the field data that there may be a relation between the bottom of outlet and a limiting sludge storage level. If this is confirmed in the experimental work now under way it would mean that the tank could accumulate sludge to a certain distance below the outlet, possibly regardless of the overall liquid depth of tank or sludge. The proper design for a particular total liquid depth would in such case be arrived at by deducting the outlet-to-sludge level distance from the total liquid depth, dividing the remaining vertical distance in proportion to the sludge and scum accumulation expectancy, and locating the bottom of the outlet slightly below the calculated bottom of scum. Here again, for design purposes, the wide variation in individual cases limits the value of an average, and provision for such a variation should be made. The detailed study of this will be presented at a later date.

We have tried recently to develop some simple way to enable sludge depth in the tank to be measured periodically by the householder. A roughened stick or a weighted string does not appear to work, but we were able, in our experimental tanks at least, to get a fair indication with a stick having a piece of toweling attached and left in contact for a half hour. Consideration might be given in design to extending the outlet tee toward the soil surface to enable access for such measurement.

As to tank behavior under various particular or special circumstances, it developed that 1.2 percent salt inhibited digestion in carboy experiments, whereas concentrations of 0.2 and 0.4 percent were not inhibiting; and that recovery developed in 150 to 200 hours with mixing and dilution after 2 to 48 hours contact at the 1.2 percent concentration, but that a concentration of

2.4 percent in two septic tanks failed to mix and dilute, the top part clearing of salt but the bottom retaining its original concentration.

As for ground garbage, comparison of the effluent characteristics of two identical experimental septic tanks operated for a year, one receiving ground garbage in addition to sewage, the other sewage only, indicated that for about nine months the effluent suspended solids of both tanks were about the same but during the last three months of the year's run the garbage tank effluent suspended solids content ran considerably more than that of the sewage tank. It is obvious, of course, that if additional solids are discharged to the tank, the rate of accumulation will increase, and that either the tank capacity must be increased accordingly, or clearings made at more frequent intervals. A previous attempt to obtain field data on accumulation rates under garbage loadings failed. We hope to take advantage of an opportunity to examine a number of installations which have been in trial operation for two years in the Jacksonville, Florida vicinity. These are identical types of tanks, with and without garbage loadings. Until further information is available, however, the 50 percent increase in tank capacity recommended by the Joint Committee on Rural Sanitation, where garbage loadings are anticipated, appears a reasonable precaution. This is not the whole story, of course. It appears that in at least one type of soil, a heavy reddish-brown clay, the garbage-sewage tank effluent clogged at a greater rate than did sewage tank effluent. This would appear to call for additional absorption area. We do not know how much at this time.

The behavior of tanks receiving wastes from households using detergents for laundering and dishwashing is a subject of current interest. There have been system failures, or failures earlier than usual, attributed to automatic sequence washers. There are several elements involved here: The quantity of waste is one, and the effect of the detergent wastes on tank action and on the soil behavior are others. We know from exploratory experiments by Rudolfs at

New Jersey on a few household type detergents that increasing detergent concentrations, up to the 100 p.p.m. tested, tend to decrease suspended solids and grease removal during short period detention. Some of the detergents are broken down fairly easily by biological action and others are not, and this may be of importance to the sewage disposal system. In a recent exploratory experiment at Cincinnati on one soil, to which supernatants from grease-soap-water and grease-detergent water mixtures were applied, it appeared that after a reduction in percolation rates in both cases there was partial recovery of initial percolation rate for the detergent-treated application as against no recovery for the soap-treated application.

As for separation of wastes for disposal in separate soil absorption lines, we see no advantage in this at this stage of our knowledge. In fact, it appears advantageous to mix the wastes and obtain seeding and digestion if possible, and to remove as much solids as possible by passing all wastes through the septic tank. Both field and laboratory study will be undertaken on this topic at the first opportunity.

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The application of proprietary compounds purported to "condition" tanks, and even to "clean" tanks is a point on which we receive inquiries rather frequently. While we cannot undertake to test the many compounds as such, we hope to complete tests on a few of the common active agents. We found through experiment that yeast did not have merit as a tank "starter" and that ripe sludge was of advantage. Preliminary indications in an experiment being made on the application of caustic soda (which is the active agent of some of the so-called "cleaners" on the market) are that rapid clogging of soil can develop. In our estimation a reasonably well designed and operated tank needs no such props and, if inadvertent discharge of interfering materials has upset tank action, the simplest and safest remedy for the protection of the all important

soil absorption system is to pump out the tank and start over.

Coming to the soil clogging studies, you will appreciate the fact that this is practically virgin territory. The project is now equipped with the services of a soil scientist, Mr. T. W.Bendixen, with a background in agricultural drainage and irrigation research. The starting exploratory studies will appear in our second report. These will indicate that initial decrease of permeability of soil when septic tank effluent is applied is primarily due to physical causes and proportional to the suspended solids added to the soil, followed by a decrease in the clogging rate, possibly due to the onset of biological activity. There appears to be an increase in the soil clogging rate caused by sewage-plus-garbage loaded septic tank effluent as compared with that of a tank receiving sewage only. Additional tests have shown filtered fresh sewage caused more clogging of the soil than normal (experimental) septic tank effluent.

Examination of data collected in the field indicates that the borderline between successful and unsuccessful tile field operation falls at sewage loading rates approximating two percent of the soil percolation test rates.

Studies of the soil percolation test procedure have been made. These show no essential difference between percolation rates in several sizes of holes tested, and the suggestion is made that a 4-inch auger hole be used to minimize the labor involved for each hole, but that replicate tests be made in the area where the tile field is to be installed. It is important that test holes in clayey types of soils be soaked overnight to permit natural saturation and swelling for design purposes.

Examination of a tile field in some detail revealed bottom trench clogging and apparent dependence on lateral movement of effluent from the trench for continued operation. Roots were concentrated in the earth and gravel below the

tile line, with a few roots above but none in the tile itself.

The opportunity is being provided in Davidson County (Nashville vicinity) by the local health department, to make some observations on tile lines under continual use in comparison with lines dosed on a yearly rotation. Distribution devices were installed in the system about nine months ago and initial soil tests made. Examinations at the first and subsequent changeover periods will be made.

As was mentioned before in connection with house sewers, pipe lines under driveways and snow cleared surfaces are weak points on freezing, and should be insulated in areas having severe winters. However, it appears that with that exception, the carefully constructed shallow household sewage disposal system with gravel packed tile lines, will rarely freeze if kept in continuous (normal) operation. This does not necessarily hold for non-residential systems, certainly not for some of the rural school systems, such as those which froze during a severe winter in Calhoun County a few years ago. During that epidemic of school freeze-ups, there were no reported residential system freezing difficulties.

So much for the studies made thus far at Cincinnati and which are being continued.

In the time remaining I would like to touch on the various recommendations which are available for your guidance. I might say, in connection with these, that the State and local health departments, the Joint Commission on Rural Sanitation and the Federal Housing Administration are kept informed on the progress of the studies at Cincinnati. Those of you who are making installations are no doubt familiar with the booklets of recommendations on design, installation and maintenance issued by those agencies. The fruits of our research studies will find application through your local and state health departments and the Federal

Housing Administration, depending on administrative arrangements, and the best advice I can give is that you make every effort to carry out the recommendations of the administrative agency. There are bound to be some differences in recommendations from area to area, because we have to take the local climate, the topography, the type of soil, and the living habits, as we find them, and adjust for them. The studies being made should help bring uniformity into many of our concepts in this field. They should be equally useful in furnishing the factual basis on which adjustments for various local environmental circumstances may also be made.

I see no reason to discuss further the various recommendations which I have just mentioned and which are available to you. In closing, however, I would like to emphasize that attention to the various technical problems will supply only part of the improvement needed in this field. Another, and no less important, factor is that of proper maintenance and servicing of these systems; in getting across to the householder the importance of a reasonable amount of attention to his facilities. You can do much in helping him to do this, in providing him a sketch of his facilities and in instructing him on inspection and cleaning requirements.